



Armed Forces College of Medicine AFCM



The motor descending tracts

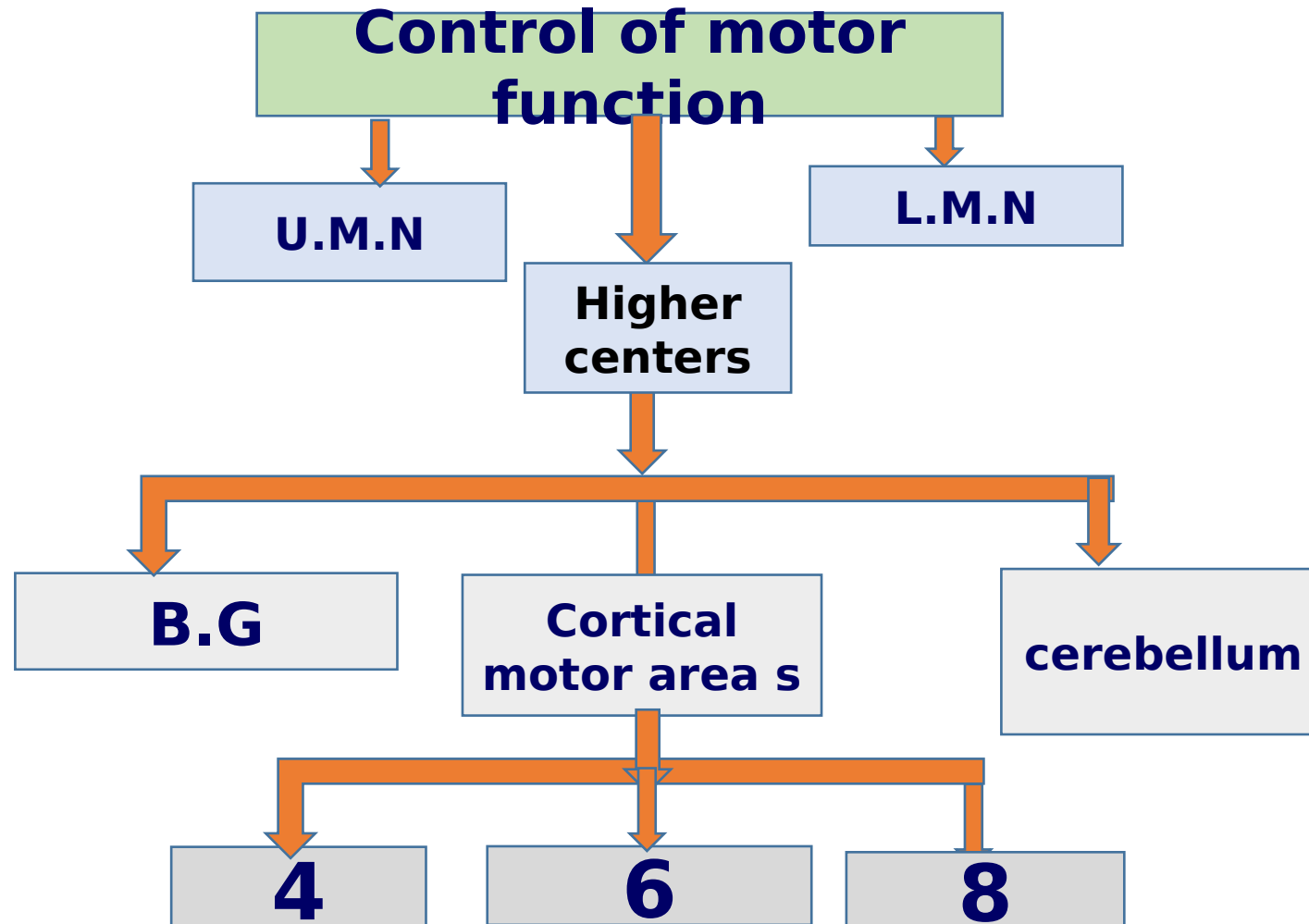
Prof. Abdelrahman Fahmy

INTENDED LEARNING OBJECTIVES (ILOs)



By the end of this lecture the student will be able to:

1. Explain the physiological significances of the descending motor tracts (Corticospinal tract , and Corticobulbar tracts)
2. Differentiate between medial and lateral descending brain stem pathways involved in motor control.
3. Describe physiological role of medial descending system: pontine and medullary reticulospinal, vestibulospinal, and tectospinal in motor control
4. Describe physiological role of Lateral descending system in motor control
5. Explain the mechanism of cortical control on axial and distal muscles.



SOMATIC MOTOR SYSTEM



Function

Control of skeletal muscle activity to produce:

- **Muscle tone.**
- **Movement** : voluntary movement and reflex action.

Voluntary Movement:

It is purposeful movement correctly ordered in time and space.

Reflex Action:

It is a subconscious response due to stimulation of receptor.

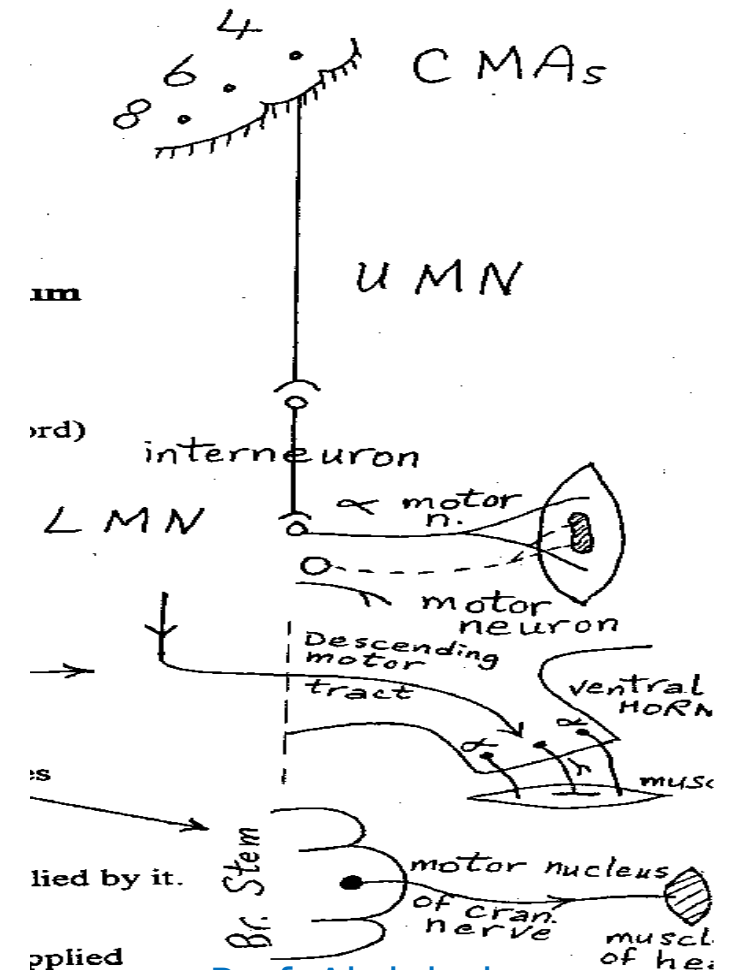
UMN (Upper motor neuron):

From level of the cortical motor areas down till A.H.C. (Sp. Cord) or cranial motor nuclei (Br. Stem). It includes:

1. Pyramidal tracts.
2. Extra Pyramidal tracts.

New Five Year Program

Neuroscience Module



Prof. Abdulrahman Fahmi

SOMATTC MOTOR SYSTEM



LMNs of Body Muscles

Ventral Horn → A.H.C. → it's axon (peripheral n.) → muscle on same side.

- LMNs of Head Muscles:

Motor nucleus of cranial nerve in brain stem → cranial nerves (all except 1,2,8) → head muscles on same side.

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Descending Motor Tracts



There are 2 main systems:

A- Pyramidal tracts:

1. Corticospinal (lateral, medial and uncrossed)
2. Corticobulbar
3. Corticonuclear

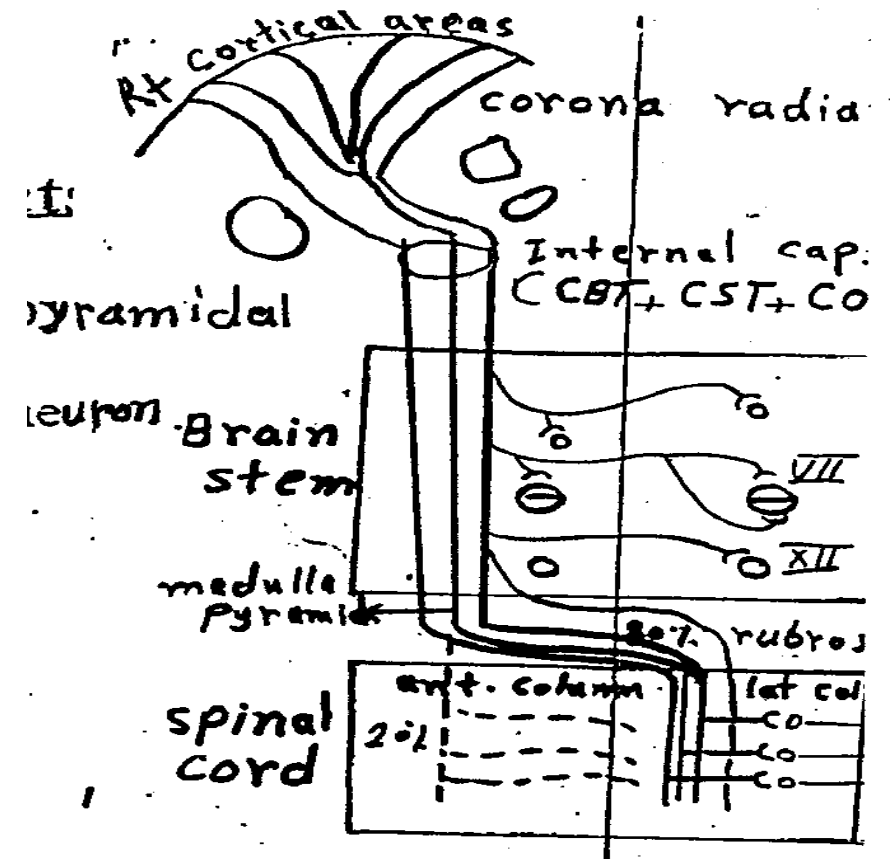
B- Extra pyramidal tracts:

All descending tracts other than pyramidal tracts

4. Rubrospinal
5. Vestibulospinal
6. Tectospinal
7. Reticulospinal

According to their position in spinal cord and anterior horn cells they are divided into:

8. Lateral motor system
9. Medial motor system



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Descending Motor Tracts



Descending Motor Tracts

Lateral Motor System

Lateral corticospinal

Rubrospinal

Medial Motor System

Ventral corticospinal

Reticulospinal

Vestibulospinal

Tectospinal

Descending Motor Tracts



| Lateral Motor System | Medial Motor System | |
|---|---|----------------------------|
| Lateral portion of anterior horn | Medial or ventral portion of anterior horn | Site of termination |
| Distal limb muscles | Trunk muscles Proximal limb muscles | Muscles innervated |
| Controls fine, skilled (discrete) voluntary movements | Controls gross movements Controls body posture Provides stable background during performance of fine movements by distal limb muscles | Function |
| Lateral corticospinal tract Rubrospinal tract | Ventral corticospinal tract Reticulospinal tracts Vestibulospinal tracts Tectospinal tract | Tracts Involved |

Descending Motor Tracts

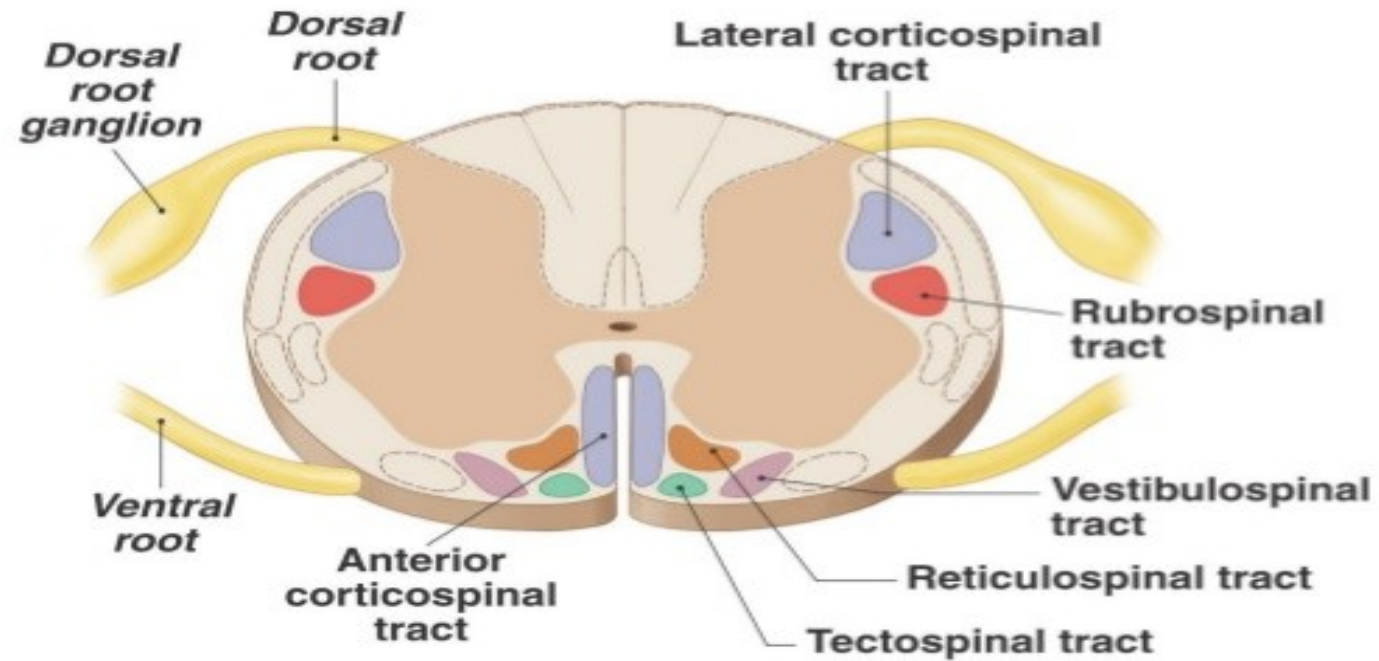


Figure 16.4b

(b) Cross-sectional view of descending motor tracts in the spinal cord

Locations of major descending motor tracts that contain axons of upper motor neurons

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Pyramidal System (Direct Activation Pathway)



One tract of 2 or 3 parts:

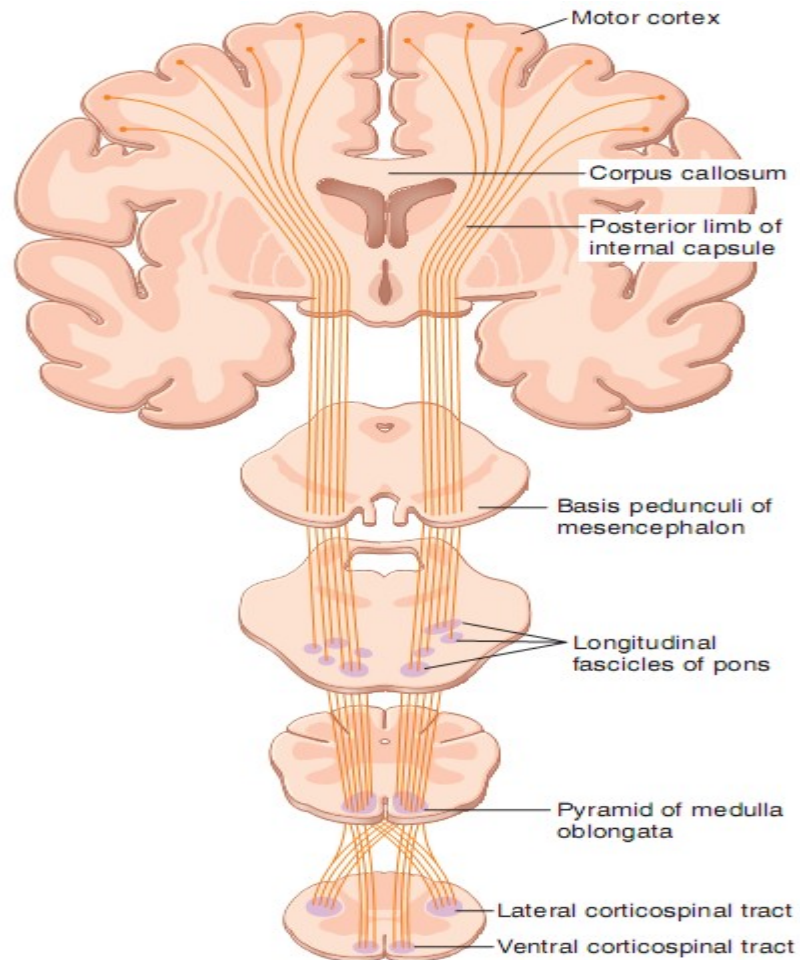
- 1. Corticospinal tract:** Control LMNs of body muscles.
- 2. Corticobulbar tract:**
Ends in brain stem, controls LMNs of cranial nerves supplying head muscles
(V, VII, IX, X, XII) on the same and opposite sides, except the lower part of VII and XII nerves (**contra lateral**).
- 3. Corticonuclear tract:**
Controls LMNs of cranial nerves supplying extra-ocular muscles of the eye (III, IV, VI).

CST (Corticospinal tract) : arises from cerebral cortex to reach A.H.C. without relay in-between.

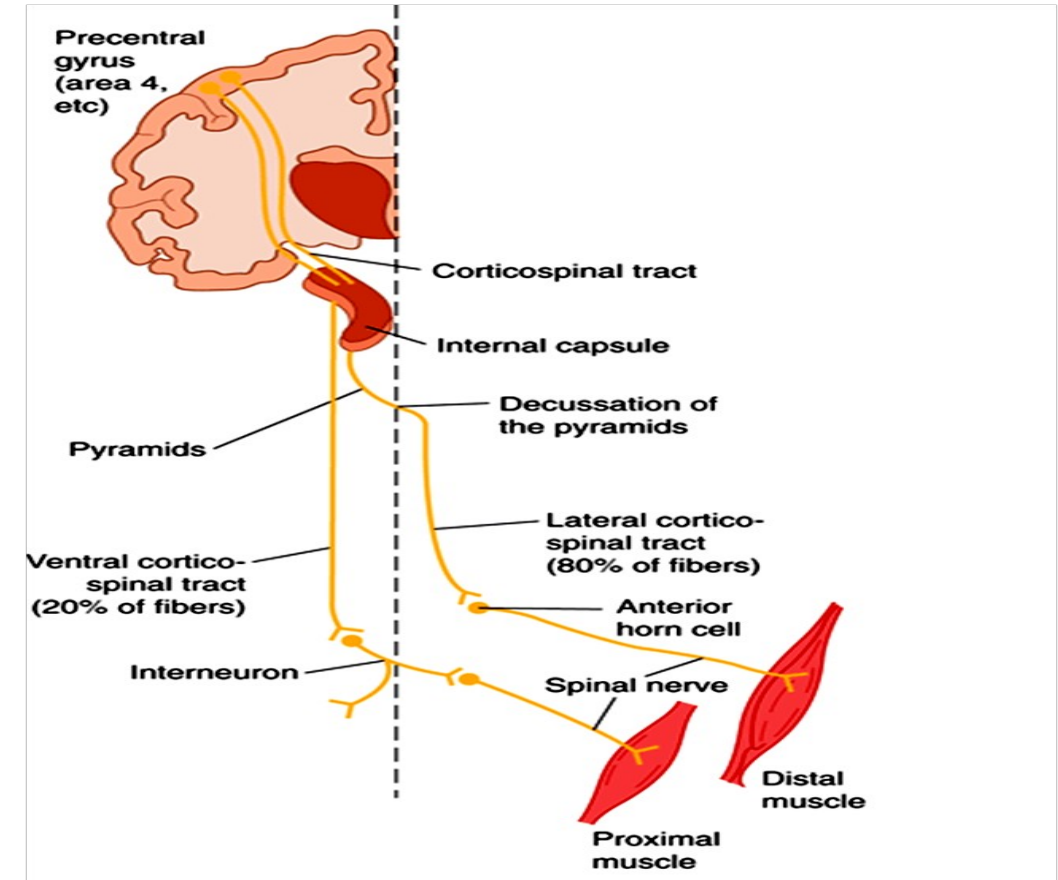
N.B. Pure pyramidal Fibers (CST) only in the pyramid of Medulla, (no pure pyramidal

lesion); So UMNL = Pyramidal + Extraparpyramidal lesions.

Pyramidal System



Guyton and Hall,
2016



Ganong, 2016

Pyramidal System



Function of Pyramidal tract:

1. Performance of fine discrete voluntary movement of head muscles (CBT)
2. CST for body muscles:
Lateral corticospinal tract: Primary pathway for initiation of skilled voluntary movements
Ventral corticospinal tract: Postural adjustments
3. Excitatory to alpha motor neuron:
 - Increased muscle tone.
 - Increased tendon jerks.
4. Necessary for superficial reflexes.
5. Necessary for flexor plantar response.

Pyramidal System



Lesion of Lateral Corticospinal Tract

- o Loss of fine movements of fingers and hands
- o Intact wrist movements

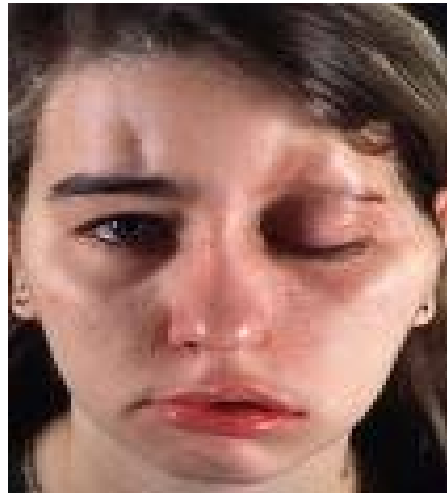
Lesion of Ventral Corticospinal Tract

- o Axial muscle deficits
- o Difficulty with balance, standing and walking

Lesion in Corticobulbar tract: Upper face is spared
N.B LMNL = Facial Palsy half of the face is affected

Lesion in corticonuclear tract: loss of conjugate movement of eye balls.

Pyramidal System

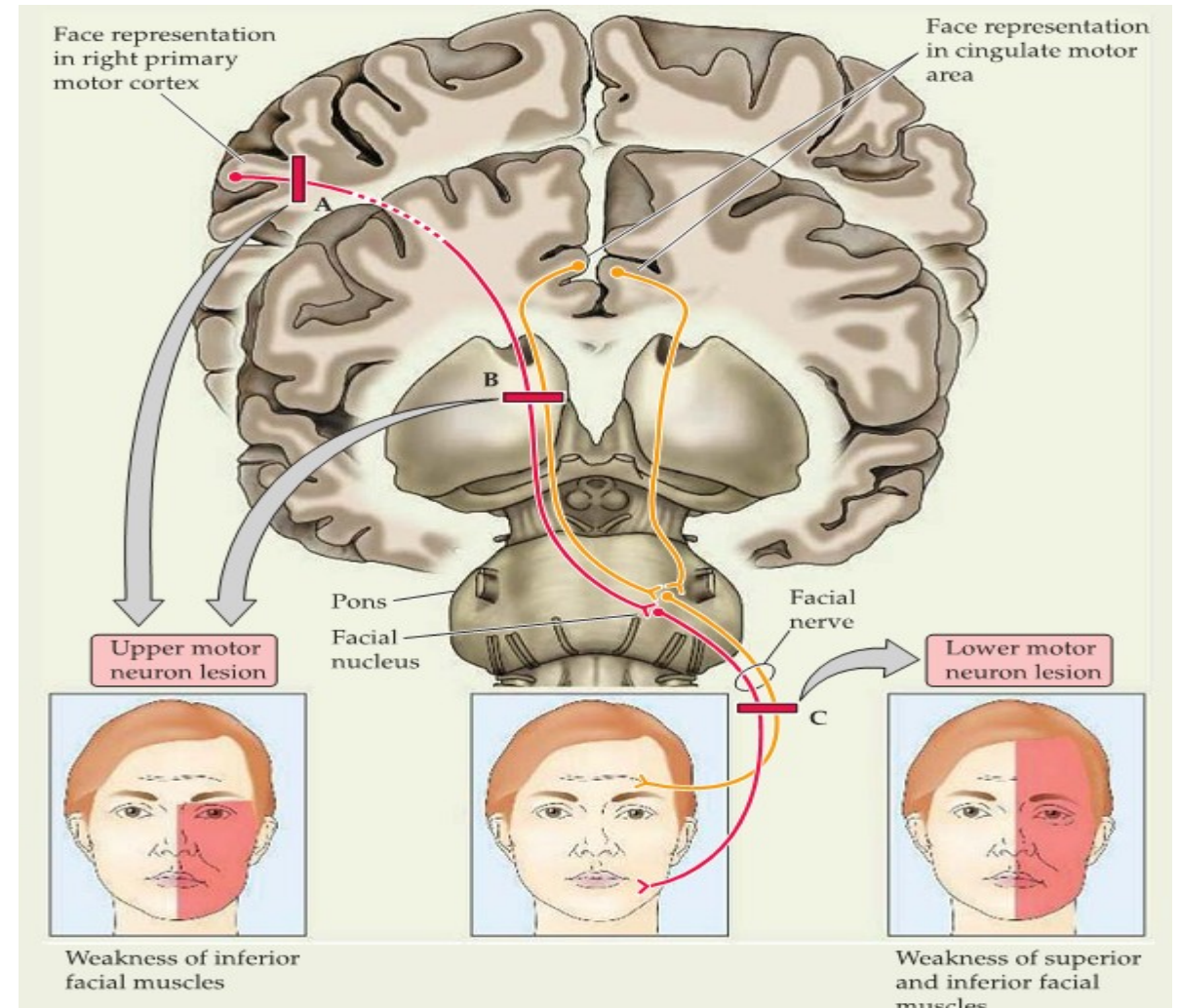


LMNL



UMNL - CBT

**UMNL-
CBT**



**NEUROSCIENCE,
2012**

Extra pyramidal System (Indirect Activation Pathway)

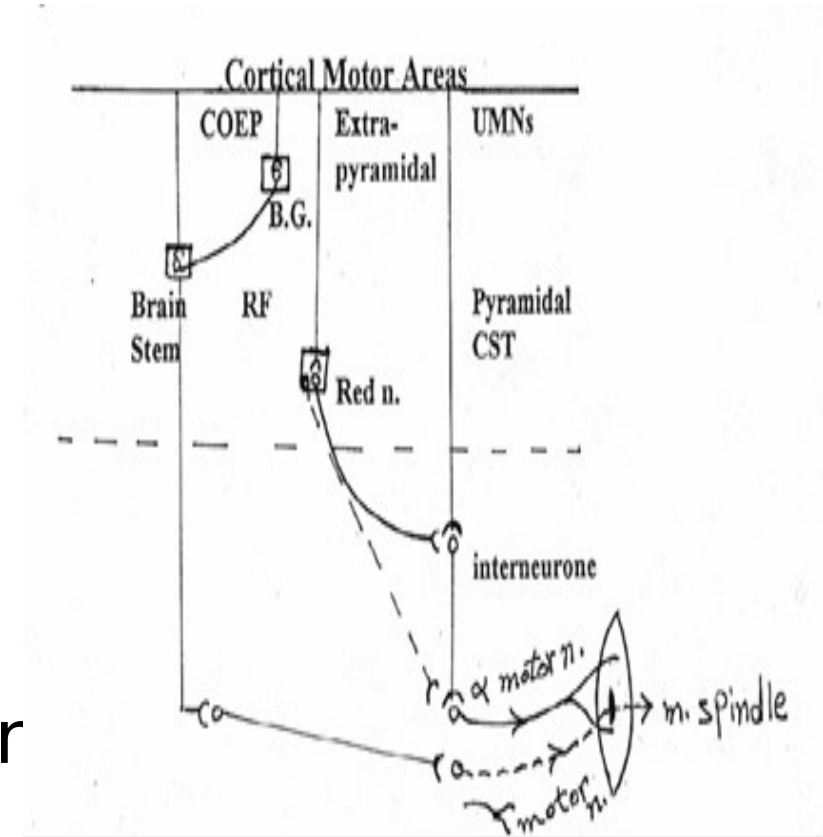


Of multiple origins:

1. CMAs(COEP).
2. Basal Ganglia.
3. RF and nuclei of brain stem.

They include Many Tracts:

1. Rubrospinal.
2. Tectospinal.
3. Vestibulospinal.
4. Reticulospinal.
5. Olivospinal.



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Extra pyramidal System (Indirect Activation Pathway)

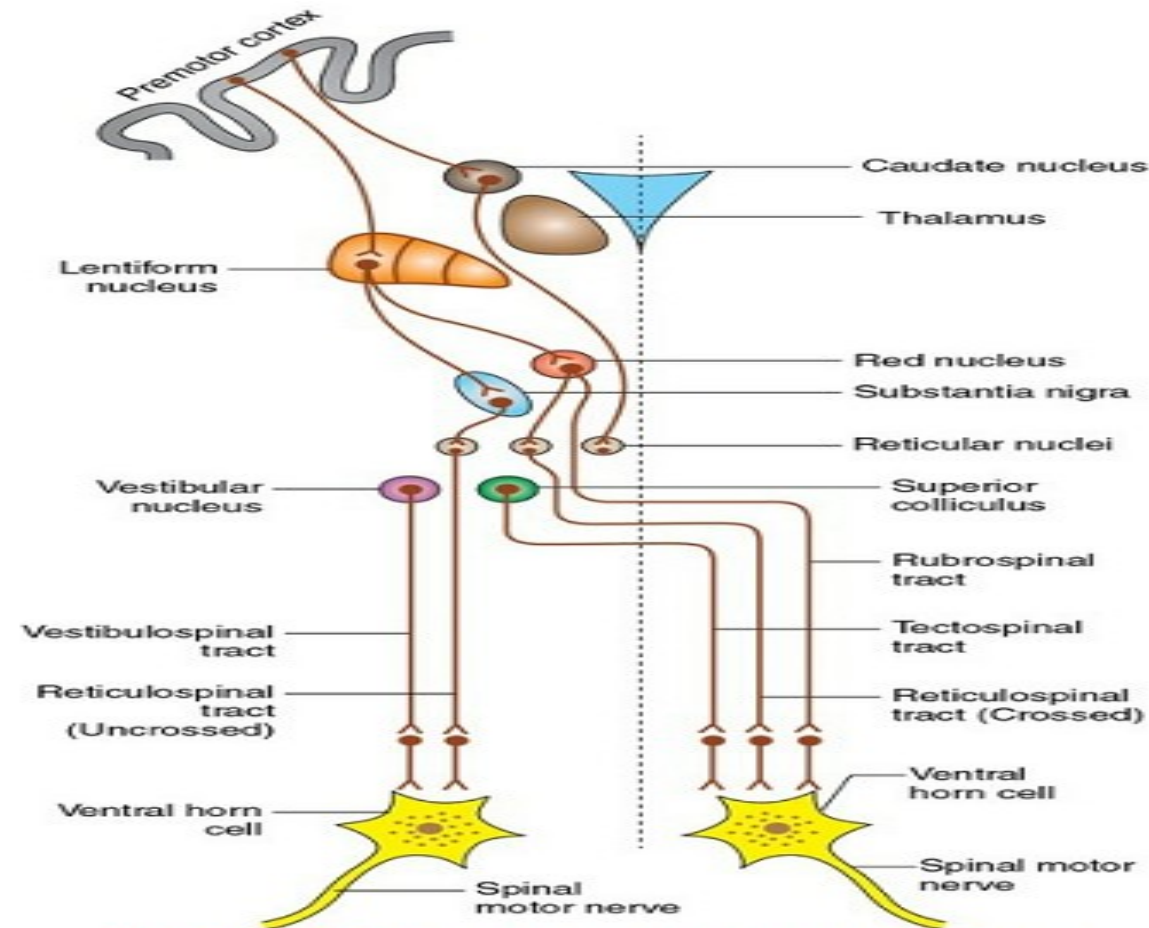


FIGURE 10.9-3 The extrapyramidal tracts.

Textbook of Medical Physiology, SECOND EDITION,
Indu Khurana, MD, 2015, Elsevier

Extra pyramidal System



Both CST and COEP (relay in red n.) end on opposite alpha motor n: 90% of fibers end on Interneuron's.

- 10% of fibers end directly.

Other COEP fibers reach: - directly → or via B.G. → inhibitory RF → control γ motor neurons activity.

N.B. CMAs controls LMNs of body muscles by:

- Direct pathway CST.

- Indirect pathway COEP that relay in red n.

While upper face muscles (head) supplied only by pyramidal tract (CBT), (**no COEP**).

Extra pyramidal System



Function of COEP Tract:

Control of axial muscles (neck-trunk) and proximal limb muscles for:

1. Performance of gross voluntary subconscious movement.
2. Movement of head and eyes towards visual or auditory stimuli.
3. Inhibitory to stretch reflex.
4. Postural adjustment to:
 - a) Maintain up-right posture.
 - b) Maintain equilibrium.
 - c) Provide the background of skilled acts.

N.B: *Extra pyramidal system = Tract + CMAs*

Descending Motor Tracts



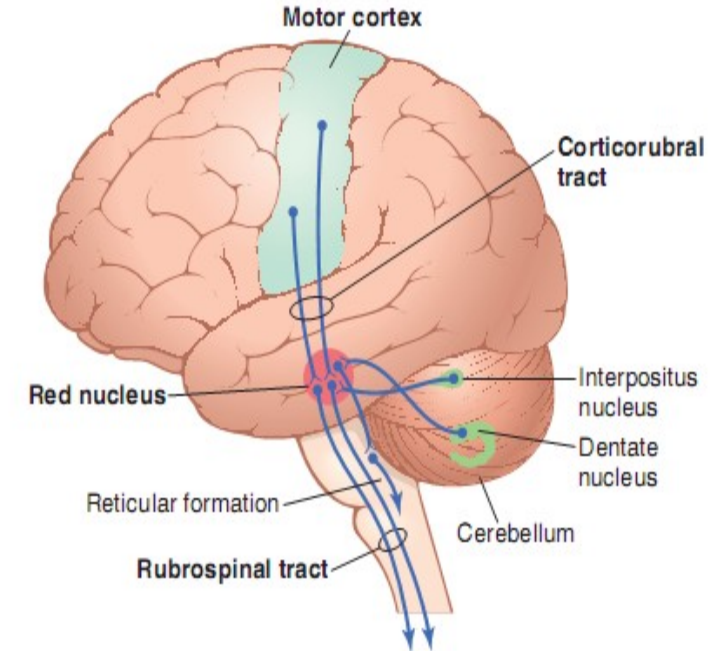
| Indirect Activation Pathway | Direct Activation Pathway | |
|--|---|-----------------------|
| COEP + extra cortical B.G. + Br. Stem | Only cortical | 1. Origin |
| About 50% crossed. | Nearly all crossed | 2. Crossing |
| Multi-neuronal | Mono-neuronal | 3. Tract |
| A.H.C. | A.H.C.+ Br. Stem | 4. Termination |
| a) Inhibitory to Stretch R. b) Control of gross and skilled movement+ autonomic + visceral. <i>N.B:</i> start function at birth. | a) Excitatory to Stretch R. b) Control of fine discrete movement <i>N.B:</i> start function after age of one year, after myelination. | 5. Function |
| Both Lost together = UMNL (No practical separate lesion) | | 6. Lesion |

Rubrospinal Tract



Function of Rubrospinal Tract

- o Serves as an accessory route for transmission of relatively discrete signals from motor cortex to spinal cord (for performance of fine skilled movements).
- o It transmits action potentials involved in the comparator function of cerebellum.
- o Inhibits deep reflex and muscle tone.



Guyton and Hall,
2016

Rubrospinal Tract



Damage of lateral corticospinal fibers with intact rubrospinal pathway

Impaired fine movements of fingers and hands + intact wrist movements

Lesion in both lateral corticospinal and rubrospinal pathways

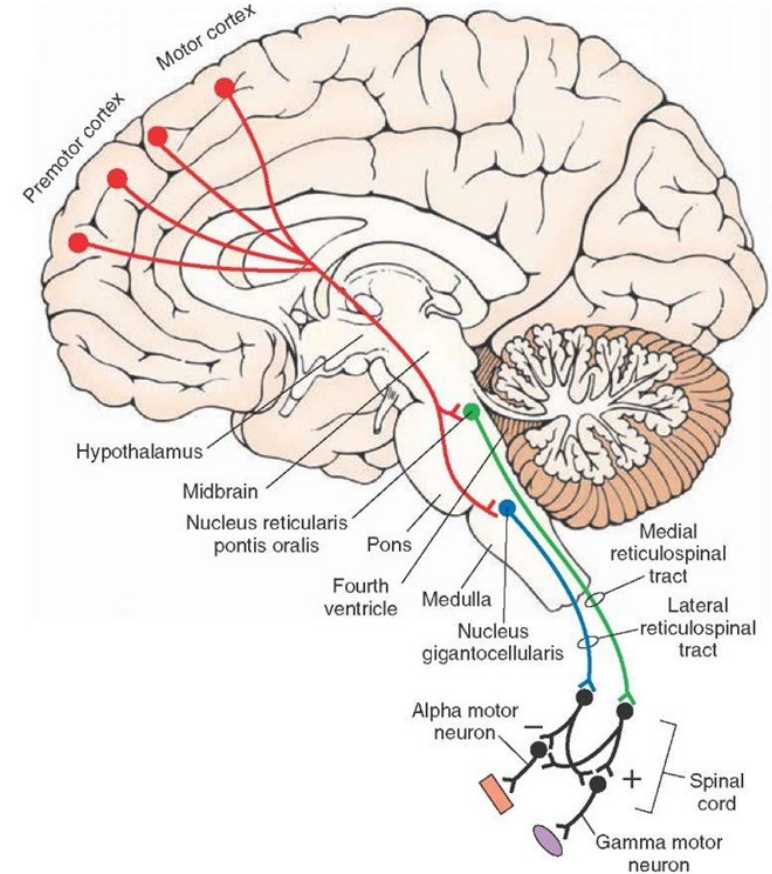
Loss wrist movements and fine movements of fingers and hands.

Reticulospinal Tract



Function of Reticulospinal Tract

- Maintenance of posture
- Modulate muscle tone, especially via influence on γ -motor neurons



<http://what-when-how.com/neuroscience/the-reticular-formation-integrative-systems-part-3/>

Reticulospinal Tract



Pontine reticulospinal tract:

Excitatory (↑ ↑ muscle tone in antigravity muscles)

Spontaneously active

Medullary reticulospinal tract:

Inhibitory (↓ ↓ muscle tone in antigravity muscles)

Normally, the inhibitory signals from medullary reticular inhibitory system counterbalance the excitatory signals from pontine reticular system.

so under normal conditions the body muscles are not abnormally tense.



Function of Tectospinal Tract

Controls head and eye movements

- Reflex turning of head in response to visual stimulus
- Reflex shift of head in response to auditory stimulus

Vestibulospinal Tract



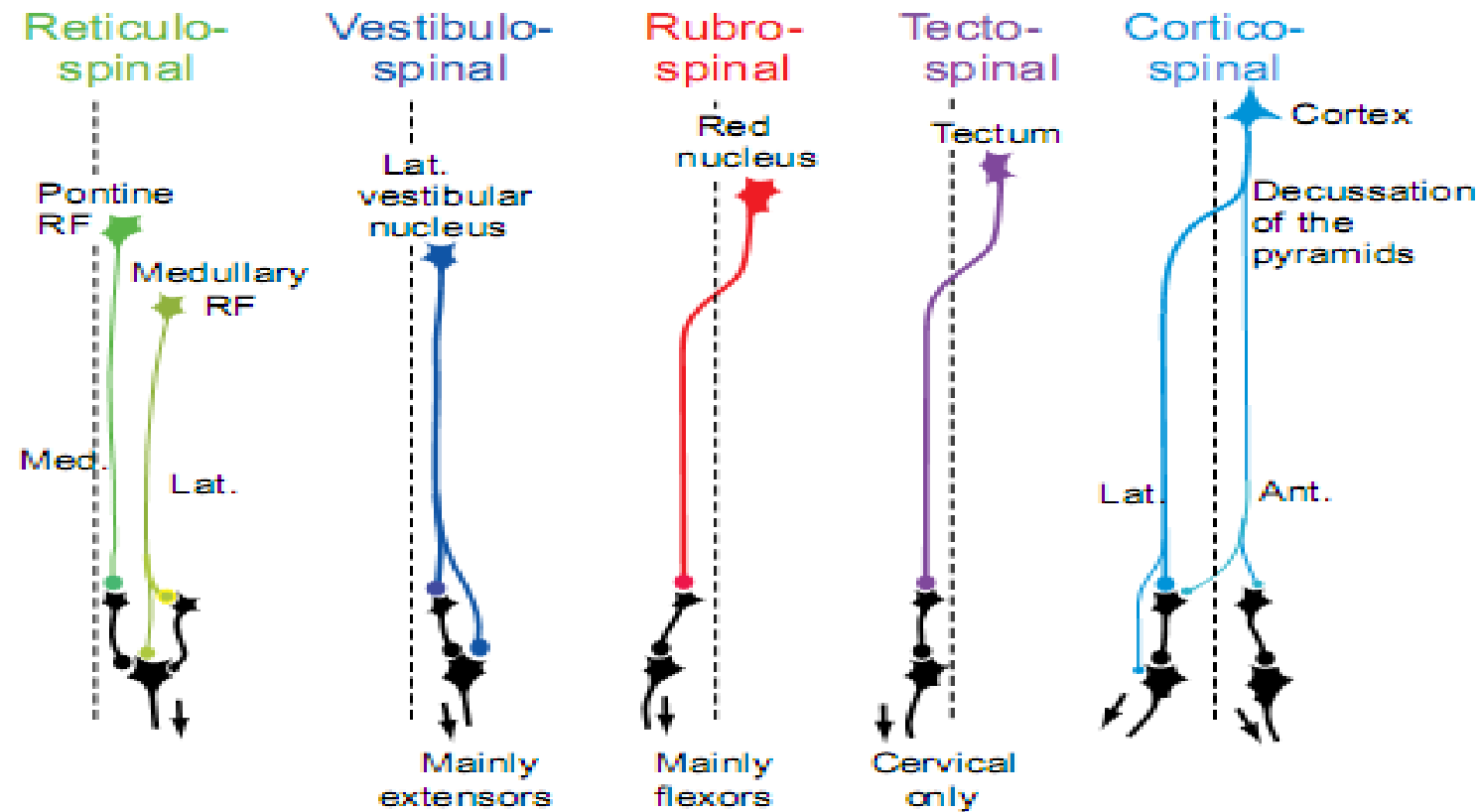
Function of Vestibulospinal Tract

- Involved in vestibular function
- It activates motor neurons to antigravity muscles (trunk and proximal limb extensors) to control posture and balance.
- Facilitation of the muscle tone.

Vestibulospinal Tract functions in association with the pontine reticular nuclei to control antigravity muscles.

Without this support of vestibular nuclei, the pontine reticular system would lose much of its excitation of axial antigravity muscles.

Descending Motor Tracts



Neurophysiology A
conceptual approach, 2012

Descending Motor Tracts



Lesion/Motor response

A = Extensor rigidity in all limbs, decerebrate rigidity/posturing

A+B = Relaxation of extensor rigidity in limb with sectioned root

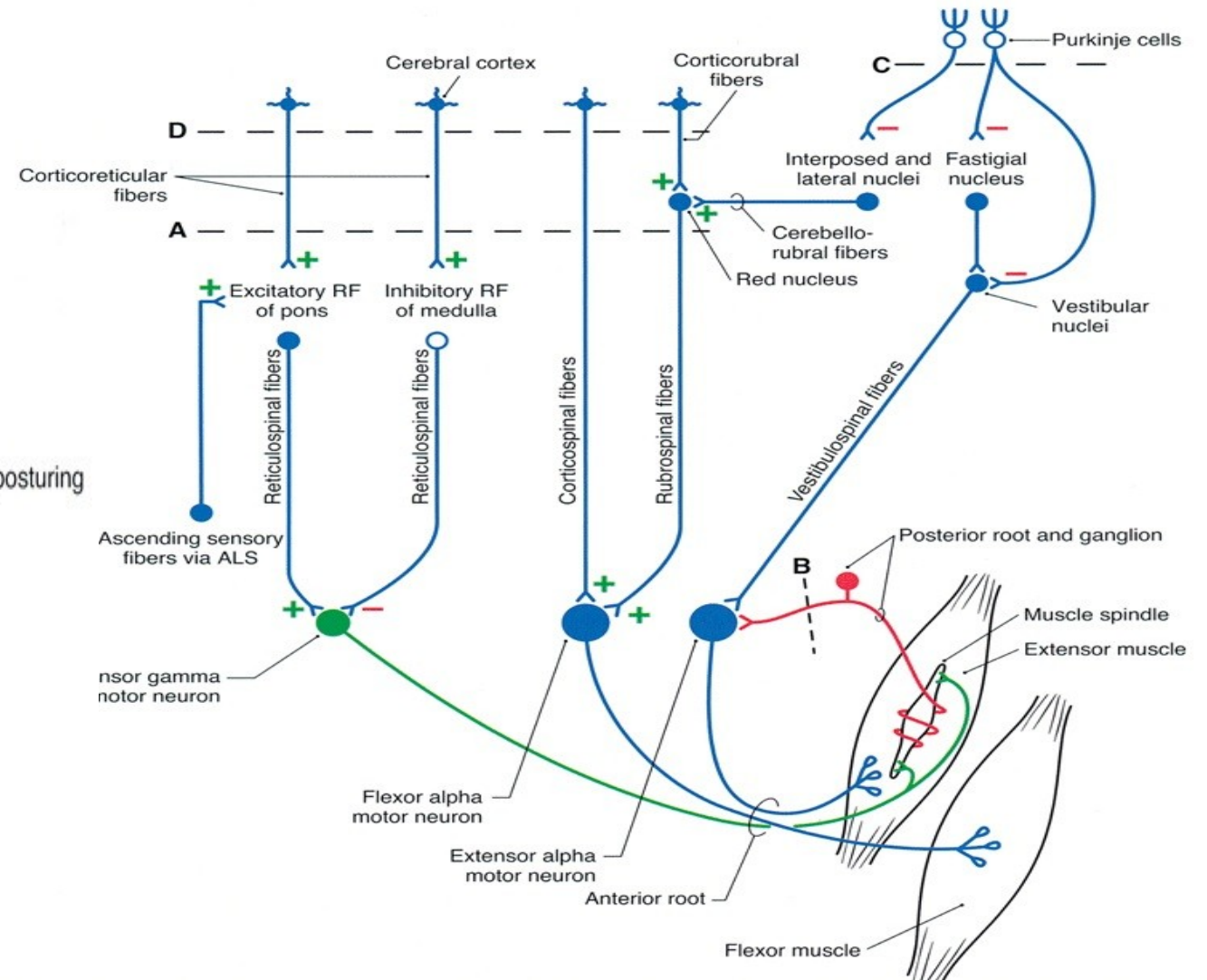
A+C = Slight enhancement of decerebrate rigidity compared to A

A+C+B = No relaxation of decerebrate rigidity

D = Flexion of upper limbs, extension of lower limbs, decorticate rigidity/posturing

Source: Barrett KE, Barman SM, Boitano S, Brooks H: *Ganong's Review of Medical Physiology*,

23rd Edition: <http://www.accessmedicine.com>





1- Which of the following is true with respect to the lateral corticospinal pathway?

- A. It must be intact to elicit a positive Babinski's sign.
- B. It synapses with gamma motor neurons in the spinal cord.
- C. It facilitate the stretch reflex.
- D. Is a multineuron pathway.
- E. Is responsible for gross movement.



2. Which of the following is true about the extrapyramidal system?

- A. Originates from cortical areas only.
- B. About 90% of its descending fibers are crossed to the opposite side.
- C. Terminates at alpha & gamma neurons in the sp. cord
- D. Starts its function during and after the first year of life.
- E. Is excitatory to the muscle tone.

SUGGESTED TEXTBOOKS



1. Guyton and Hall textbook of medical physiology, thirteenth edition 2016, Elsevier, chapter 56 , from page 707 to 719
2. Ganong's Review of Medical Physiology, twenty-fifth edition 2016, McGraw-Hill Education, chapter 12, from page 227 to 254

Thank You